Defining major trauma: A Delphi study.

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Abstract

Introduction: Retrospective trauma scores are often used to categorise trauma, however, they have little utility in the prehospital or hyper-acute setting and do not define major trauma to non-specialists. This study employed a Delphi process in order to gauge degrees of consensus/disagreement amongst expert panel members to define major trauma.

Method: A two round modified Delphi technique was used to explore subject-expert consensus and identify variables to define major trauma through systematically collating questionnaire responses.

After initial descriptive analysis of variables, Kruskal-Wallis tests were used to determine statistically significant differences ($p \leq 0.05$) in response to the Delphi statements between professional groups. A hierarchical cluster analysis was undertaken to identify patterns of similarity/difference of response.

A grounded theory approach to qualitative analysis of data allowed for potentially multiple iterations of the Delphi process to be influenced by identified themes.

Results: Of 55 expert panel members invited to participate, round 1 had 43 participants (Doctor n=20, Paramedic n=20, Nurse n=5, other n=2). No consistent patterns of opinion emerged with regards to professional group. Cluster analysis identified three patterns of similar responses and coded as trauma minimisers, the middle ground and the risk averse. Round 2 had 35 respondents with minimum change in opinion between rounds.

Consensus of ≥70% was achieved on many variables which included the identification of life/limb threatening injuries, deranged physiology, need for intensive care interventions and that extremes of age need special consideration. It was also acknowledged that retrospective injury severity scoring has a role to play but is not the only method of defining major trauma. Various factors had a majority of agreement/disagreement but did not meet the pre-set criteria of 70% agreement. These included the topics of surgical intervention, use of Tranexamic Acid, burns, spinal immobilisation and whether a major trauma centre is the only place where major trauma can be managed.

Conclusion: Based upon the output of this Delphi study, major trauma may be defined as: “Significant injury or injuries that have potential to be life-threatening or life-changing sustained from either high energy mechanisms or low energy mechanisms in those rendered vulnerable by extremes of age”.

Background

Within the last 100 years human life expectancy has changed and we are now living longer where men can be expected to live until 79.3 years and women 82.9 years with the overall population in England and wales increasing by 64% within that period. The causes of death over this period has shifted dramatically from infections as the primary cause in 1915 to a more complex distribution throughout a century of medical, industrial and social innovation. For all ages, ischaemic heart disease and dementia and Alzheimer’s disease is a common cause of death with cancers and ischaemic heart disease more apparent in the older age groups. The very young (1-4 years) mostly die from congenital malformations, deformations and chromosomal abnormalities. Deaths in older children through to middle age include suicide, injury and poisoning as the main causes (1). For over 20 years injury is the most common cause of death for women aged 10 to 30 years and for men aged 15 to 35 years (2).

In 2017 the North East region of England had the highest age-standardised mortality rate at 1,090.1 deaths per 100,000 population (3). However, major trauma remains a relatively rare cause of death within England and Wales. The lack of exposure to major trauma can cause anxiety and our perception of what is classified as major trauma is potentially complex.

Although high energy mechanisms are often associated with major trauma, Kehoe, Smith (4) have challenged this assumption. They highlight the change in major trauma patient groups who are now more elderly and have significant injuries with high injury severity scores (ISS) as a result of low energy mechanisms such as a fall from standing height.

A literature review (5) identified that the most common definition for major trauma is a retrospective ISS of >15. The injury severity score is an aggregation of the main injuries from each body region. All injuries receive a code which is generated from the Abbreviated Injury Scale (AIS) dictionary and each body region is scored 1-6 and then squared and the three highest scores added together. These scores have little utility in the prehospital and hyper-acute settings as accurate AIS codes are only generated after hospital imaging is completed (6). They also do not fully describe major trauma to the non-specialist. With a lack of a descriptive definition (7) and in the absence of ISS, it is important to be able to define major trauma and provide context to prehospital, emergency medicine clinicians and non-specialists.

This study employed a Delphi process in order to gauge the degrees of consensus and disagreement amongst expert panel members, their views and definition of major trauma.

Delphi techniques have previously been used in order to seek expert consensus in prehospital care matters (8-10). Delphi methodology has been subject to criticism on the basis of methodological flaws, most notably: sampling and use of ‘experts’; anonymity; and the issue of enforced consensus (11).

The study authors remained cognisant of these criticisms during the design phase of this study.

The research question assumed an exploratory focus:

“Which factors do subject experts and current prehospital care practitioners identify in defining major trauma in the absence of injury severity scores?”

The specific aims of the study included:

- To utilise the Delphi techniques in order to distil subject expert opinion concerning the definition of major trauma; and,
- To critically explore the extent of consensus in the definition of major trauma in the absence of ISS.

Methods

Study design and setting

A two round modified Delphi technique (with a potential third) was employed in order to explore subject-expert consensus and identify in-situ use of variables to define major trauma in the absence of ISS through systematically collating questionnaire responses.

Grant, Booth (12) recommend that the Delphi should conclude after predetermined multiple iterations or when consistency between rounds is stable with unchanging opinion.

Definition of consensus

Mubarak, Hatah (13) highlight that 100% agreement can be achieved among experts and that an arbitrary percentage should be set prior to undertaking the study. Within our Delphi design, Likert type scales were used which give the option of a neutral response. With this in mind the research team set the arbitrary percentage of 70% agreement (positive or negative) as subject-expert consensus where the neutral score was not considered. The exception to this would be if the group agreement was more than or equal to a 70% neutral response.

The exploratory nature of the Delphi study allowed for feedback to be provided to the expert panel using group responses. This was believed to provide new information that may generate new perspectives to achieve a group consensus.

The survey was designed to reflect the outcomes of a literature review (5) and the output from three focus groups (14). This included:

- clinician factors, such as experience and exposure,
- patient factors, such as physiology, outcome measures and pre-trauma factors'
- situational factors, such as mechanism of injury.

Question domains were designed in order to ascertain potential clustering factors including both observable (e.g. profession, experience and age) and unobservable factors (e.g. values, attitudes, opinions and preferences).

Sampling of study participants (expert panel)

The expert panel members, who will be referred to as participants within this study, were from a broad range of professional groups who are exposed to and manage major trauma patients within their everyday workplace. Panel members were purposively selected based upon diversity of experience and expertise within a single trauma network.

Whilst there are no absolute guidelines as to the number of participants that may contribute to the Delphi process (11), the aim was to have at least three individuals from each relevant professional group within the Northern Trauma Network (NTN) which covers the North East and Cumbria areas of England.

Data collection and management

Ethical approval was granted through Integrated Research Application System (IRAS project ID: 237977).

We utilised a Delphi method with two iterations of questionnaires. The survey was conducted using the online system SurveyMonkey Inc. (San Mateo, California, USA). Panel members remained anonymous to one another throughout the data collection and analysis process. The Delphi study commenced on 12 December 2018 and ran through to 5 November 2019.

All data collected were stored electronically in a secure and password protected folder and anonymised prior to analysis.

Validity and Reliability

Sackman (15) suggested that the Delphi processes fail to meet standards of reliability and validity '*normally set for scientific methods*.' However, careful scrutiny of Sackman's assertions reveal that his concerns relate more to the methodological shortcomings of *particular studies* rather than overall methodological approach *per se*.

Anonymised results are believed to prevent attrition of panel members who may have a minority opinion (16). A short Pilot Study was carried out to refine the wording of the surveys and to remove potential ambiguities and ensure reliability of responses. All responses were anonymised and peer reviewed prior to any analysis and sharing with the panel members at repeated iterations between surveys.

Data Analysis

All quantitative data analysis was undertaken using the Software Package for the Social Sciences (SPSS; Version 26, IBM Inc.; Armonk, NY, USA).

After initial descriptive analysis of variables, Kruskal-Wallis tests were used to determine statistically significant differences ($p \leq 0.05$) in response to the Delphi statements between the professional groups within the sample e.g. Doctors, Paramedics, Nurses and others which included managers, academics and administrators. The term 'other' was used to prevent unique individuals within specialised professional groups from being easily identified.

The Kruskal–Wallis test is a statistical method for ascertaining the significance of differences between the median values for *K+* sub-groups from within the same sample: this is the test of choice when analysing ordinal data such as that generated by the Delphi instrument.

As no consistent patterns of opinion emerged in relation to professional group membership (Doctor / Paramedic / Nurse / other), a hierarchical cluster analysis was undertaken in order to identify patterns of similarity and difference of response within the data. Yim and Ramdeen (17) identified that '*Cluster analysis refers to a class of data reduction methods used for sorting cases, observations, or variables of a given dataset into homogeneous groups that differ from each other.*' Cases (individual participants) are clustered based upon chosen characteristics – in this instance, similarity in the way they scored selected Delphi statements – *and NOT their professional grouping*. Cases in each specific cluster share many characteristics but are also dissimilar to those not belonging to that cluster. A three-cluster solution proved most economical and was ascertained using Ward's method and squared Euclidian distance as a means to determine cluster membership. This process minimises variance within each cluster.

Cluster analyses are data reduction methods that are used for sorting cases, observations, or variables of a given dataset into homogeneous groups that differ from each other (17). In the current study, the analysis procedures identified clusters based upon similarity in response to the Delphi statements. Arranging response patterns together and classifying these as belonging to different broader groups provides a means of applying some organisation to individual Delphi responses, which at first sight might appear highly individualised or even chaotic. The technique of cluster analysis originated in biology and ecology (18) and although the technique has been reasonably widely employed in social science analysis, it has not (to date) gained the same level of application in health research.

Free text data generated by questionnaire responses were managed and analysed using NVivo qualitative data analysis software, QRS International Pty Ltd., Version 11, 2015. Data were coded and reviewed to identify emerging themes (19).

A grounded theory approach to qualitative analysis of the data allowed for potentially multiple iterations of the Delphi process to be influenced by the generated data and themes identified. This inductive approach allowed for theoretical insights to be generated as the process was undertaken rather than testing preconceived hypotheses (20). Within the context of this study it allowed for a thematic framework of nine areas.

Results

Figure 1 highlights the Delphi study process and the frequency of responses throughout.

Table 1 describes the frequency of responding participants professional group alongside experience in years, including range and mean.

Table 1 Delphi participants by professional group and experience.

Professional group Round 1 (n)	Experience in years Range (mean)*
Doctor (20)	6 - 21+ (14)
Paramedic (16)	6 - 20 (14)
Nurse (5)	0 – 21+ (12)
Other (2)	Not recorded
Total (43)	0 – 21+ (13)

*Rounded

Due to the level of expertise within very specific professional disciplines which specialise in major trauma, participants were placed into generic professional groups to prevent identifying individuals and potential bias. These groups were used within the context of the cluster analysis to identify differences between specific group responses. Table 2 highlights the response rates to each round of the study by professional group.

Table 2 Delphi participants by professional group and response rates.

Invited to participate by professional group (n)	Round 1 n (Response %)	Round 2 n (Response %)
Doctor (20)	20 (100)	14 (70)
Paramedic (20)	16 (80)	16 (80)
Nurse (10)	5 (50)	3 (30)
Other (5)	2 (40)	2 (40)
Total (55)	43 (78)	35 (64)

Round 1

Because no consistent patterns of opinion emerged in relation to professional group membership (Doctor / Paramedic / Nurse), a cluster analysis was performed in order to identify patterns of similarity of response within the data (whilst ignoring whether responses were made by professional group).

Three distinctive clusters were identified and their composition by professional group is highlighted in table 3. Participants who did not complete the relevant sections of the questionnaire (n = 7) were excluded from the cluster analysis.

Table 3 Composition of clusters.

Cluster	N (%)	Composition (%)
1	9 (25)	4 Doctors (44) 4 Paramedics (44) 1 Nurse (11)
2	20 (56)	10 Doctors (50) 7 Paramedics (35) 3 Nurses (15)
3	7 (19)	5 Doctors (71) 1 Paramedic (14) 1 Nurse (14)
Total	36 (100)	19 Doctors (53) 12 Paramedics (33) 5 Nurses (14)

Clusters 2 and 3 were very closely linked together and all clusters produced a normal distribution pattern.

Cluster 1 were coded as “Trauma Minimisers” owing to their answers indicating a high threshold for identifying major trauma. In relative terms, from a given number of trauma patients, cluster 1 participants would identify a very low percentage as major trauma.

Cluster 2 were coded as “The Middle Ground”. This cluster represented the majority of the Delphi participants as well as their respective professional groups. Cluster 2 identified what would be considered an appropriate proportion of major trauma based upon existing criteria.

Cluster 3 were coded as “Risk Averse” as their answers indicated a very low threshold for identifying major trauma. From a given number of trauma patients cluster 3 would identify a high percentage as major trauma.

Seven participants out of a total of 43 participants did not answer all the questions within the questionnaire and were excluded from the cluster analysis based on the limited availability of data.

Table 4 highlights the areas of consensus within the first round Delphi questionnaire that was predetermined as ≥70% agreement.

Table 4 Consensus on variables (Delphi round 1)

Variable	Consensus (≥70%)	%
Actual injuries	Yes	100 (>med)
Only high energy mechanisms should be considered	Yes	97.5 (>disagree)
Physiology	Yes	97.44 (>med)
Need for blood products	Yes	92.3 (>med)
Age (>65 years) special consideration	Yes	89.75 (>med)
Experienced clinicians are able to identify major trauma patients	Yes	89.74 (>agree)
Need for ventilatory support	Yes	89.47 (>med)
Intoxication makes triage difficult	Yes	87.5 (>agree)
Age (paediatric)	Yes	87.18 (>med)
Age has no relevance	Yes	85 (>disagree)
Low energy mechanisms should be considered	Yes	85 (>Agree)
Elderly require different assessment/management	Yes	85 (>agree)
Need for surgical intervention	Yes	84.61 (>med)
Triage tools always identify major trauma	Yes	82.5 (>disagree)
Mechanism of injury (MOI)	Yes	82.5 (>med)
Scoring systems are the only way to identify major trauma	Yes	76.92 (>disagree)
Paediatrics require different assessment/management	Yes	77.5 (>agree)
Identified by clinical assessment (as opposed to mechanism of injury)	Yes	77.5 (>agree)
Can only be defined by retrospective scores	Yes	75 (>disagree)
Perceived need for Intensive Care Unit admission	Yes	75 (>agree)
Outcome measures (e.g. injury severity scores)	Yes	71.8 (>med)
Pre-existing frailty should be considered	Yes	70 (>agree)
Need for tranexamic acid (TXA)	No	69.22 (>med) 30.77 (Low)
Need for pelvic binding	No	64.1 (>med) 35.9 (low)
Perceived need for surgical intervention	No	62.5 (>agree) 22.5 (neutral) 15 (Disagree)
Major trauma can only be managed at an MTC	No	62.5 (>disagree) 15 (neutral) 22.5 (agree)
Need for spinal immobilisation	No	61.54 (low) 38.47 (>med)
Clinicians high index of suspicion can identify major trauma without imaging	No	60 (>agree) 15 (neutral) 25 (disagree)
Burns should have a separate protocol	No	57.9 (>agree) 26.32 Neutral) 15.79 (disagree)
Previous medical history	No	56.41 (low) 43.59 (med)
Burns should be included in major trauma triage	No	55.27 (>agree) 7.89 (Neutral) 36.85 (disagree)
Pre-existing co-morbidity should be considered	No	51.28 (>agree) 25.64 (neutral) 23.08 (disagree)

A single question within Delphi had a simple list of variables that could be acknowledged as the main variables that define major trauma. Table 5 highlights the key variables from that list that achieved consensus from the Delphi participants.

Table 5 Key variables highlighted by participants in round 1

Variable identified	Consensus (≥70%)	%
Life threatening injuries	Yes	95
Limb threatening	Yes	92.5
Major blood loss	Yes	87.5
Suspected abdominal injury with haemodynamic instability	Yes	80
Injury causing reduced consciousness	Yes	72.5

There was an obvious consensus on many of the variables highlighted as defining major trauma. There were however some statistically significant variations in agreement between clusters in other variables (level of significance set as $p < 0.05$). These variations in agreement are described in table 6.

Table 6 Variables where significant variation in agreement differs between clusters.

Variable	Difference between clusters (C)			p Value*
	Cluster	Differs from	Cluster	
Identifier for major trauma				
Need for spinal immobilisation	1	Differs from	2	<0.01
Need for pelvic binding	1	Differs from	2 & 3	0.01
Age has no relevance within major trauma	3	Differs from	1 & 2	0.01
Burns				
Should be inc. within major trauma triage tool	3	Differs from	1 & 2	<0.01
Burns should have a separate protocol	1	Differs from	2 & 3	<0.01
Defining major trauma				
Pre-existing frailty should be considered	1	Differs from	2 & 3	<0.01
Pre-existing comorbidities should be considered	1	Differs from	2	<0.01

* p value rounded to 2 decimal places (Independent samples Kruskal-Wallis test).

The free text within the questionnaire was explored using a qualitative approach to coding of free text. The grounded theory approach allowed the following iteration of the Delphi process (round 2) to be influenced by the emerging themes that was represented in the thematic framework in table 7 which highlights the frequencies of identified coded variables.

Table 7 Frequency of variables highlighted in qualitative analysis of free text.

Variable	n
Significant injury/Polytrauma	24
Life threatening/changing/disability	18
Mechanism of Injury (MOI)	14
Specialist input (Inc. Surgery, Blood transfusion)	12
Physiological changes	10
Prolonged treatment/Rehab	8
Age	6
Previous medical conditions	3
ISS	1
Total number of variables	96

Round 2

Of the original 43 respondents from the first round, 35 participants completed the second round of the Delphi. Several members had since left their original place of work and were unable to be contacted.

The data were analysed to see if there were any significant change in answers by the panel members after they had received the feedback from round one. Non-parametric related-samples Wilcoxon Signed rank test was utilised with the significance level set at ≤ 0.05.

Using the same questionnaire which was modified based upon round 1 responses, there were no significant changes to any responses between round 1 and round 2 except for “Major trauma patients can only be managed at an MTC” which still did not achieve a consensus. There were several variables which were almost significant, but the overall consensus was less than the agreed 70% and therefore table 4 remained relatively unchanged.

Discussion

Statement of principle findings

The areas of consensus highlighted in Table 5 were replicated throughout the study. They highlight that life and limb threatening injuries are without doubt the variables that define major trauma. Included within that table are major blood loss, abdominal injury with haemodynamic instability and reduced consciousness which could be addressed under deranged physiology. Deranged physiology could also be argued to highlight life and limb threatening injuries. It was also noted that only using high energy mechanisms should be discounted. This is reflected in the work by Magnone, Ghirardi (21), Potter, Kehoe (22) and Stuke, Duchesne (23) who highlight that, in isolation, mechanism of injury does not correlate well with outcomes.

The participants within this study do not change their opinions between rounds in any significant way. Also, during the cluster analysis there was no clear difference in response between individual disciplines and each cluster had an even distribution of professional groups.

In the main, consensus was achieved in many variables highlighted within the study. However, several aspects did not meet the agreed consensus level such as the need for TXA, pelvic binding and surgical intervention. Although, the majority of participants agreed that these variables were considered indicative of major trauma they did not meet the agreed 70% for consensus. Although two burns questions were proposed to the participants, a non-consensus reaching majority paradoxically agreed that burns should have a separate protocol from the major trauma triage tool and yet also be included in the major trauma triage tool. These conflicting statements may be due to the wording and placement of the statements within the questionnaire which may provide further context and understanding but to this end no real explanation can be concluded for this.

Again, the majority, but not meeting the prespecified consensus level, disagree that major trauma can only be managed at an MTC. This may reflect the views of the regional specialists that are distributed throughout the trauma units or that sub-groups of patients may be best managed locally.

A low percentage of agreement on whether to consider comorbidities and previous medical history in identifying potential major trauma may be reflective of the composition of the participants within the Delphi study. Owing to the nature of the research topic, in the context of defining major trauma in the hyper-acute phase of care, there was an obvious lack of participants from the rehabilitation and long-term care disciplines. These sub-acute disciplines may have an alternative perspective with regards to the variables that should be considered in defining major trauma.

It is perhaps reassuring and a testament to the specialist/expert participants that a patients actual injuries are a primary focus in identifying major trauma and also based on that patients individual circumstances. A bespoke model taking into account the unique nature of that episode of care that includes their age and physiology expected for that individual and that not all mechanisms are equal based on an individuals unique response. It is also noted that experts within the hyper-acute trauma setting do not agree with triage tools and scoring systems being able to identify all major trauma. This may reflect the wealth of experience and exposure to major trauma within the participant group and a common theme that ran through the study was that major trauma is unique to the individual at that time where injury/injuries threaten life or limb.

Strengths and weaknesses of the study

The Delphi study provided a technique to gain consensus on defining major trauma by the experts within that specialist area across disciplines. The regional trauma network and the individuals who work within the region are a very close community. There may be a risk of unintentional homogenous thinking due to the isolated nature and familiarity within the group. There is also a risk of excluding the views and perceptions of those who are not specialists or who work in the sub-acute disciplines within the region. It is believed that the definition of major trauma will be transferable and generalisable within all settings but perhaps may be also idiosyncratic to the local region.

There was a significant drop out rate between both rounds (round 1 n=43, round 2 n=35), however, this is not uncommon in relation to repeated administrations of the same survey.

Strength and weaknesses in relation to other studies, discussing important differences in results

The author(s) are/is unaware of any consensus study into defining major trauma in the absence of ISS or other scoring mechanisms. It is therefore difficult to compare this study to other studies or literature.

Meaning of the study

This Delphi study highlights the group consensus of the NTN to the definition of major trauma in the hyper-acute setting. It was interesting that although clusters were created (trauma minimisers, the middle ground and the risk averse) there was no real difference in composition within those clusters highlighting that differences were not based on profession. It is hoped the concluding definition can provide a reference for non-specialists, academics and/or clinicians where retrospective scoring systems provide little context or meaning.

Unanswered questions and future research

The definition of major trauma from this Delphi study is subjective and therefore open to interpretation. ISS or other scoring systems provide an objective measure but have very limited utility within the hyper-acute setting. Future research may be able to identify an objective measure that considers the principles within this study.

Conclusions

Based upon the previous literature review, focus groups and the output of this Delphi study, major trauma may be defined as: “Significant injury or injuries that have potential to be life-threatening or life-changing sustained from either high energy mechanisms or low energy mechanisms in those rendered vulnerable by extremes of age”.

Declarations

Ethics approval and consent to participate

IRAS Project ID: 237977. Each participant was subject to informed consent prior to participating in the Delphi study.

Consent to publish

All contributing authors consent to publish.

Availability of data and materials

The data generated for the Delphi study is available upon reasonable request to the lead author.

Competing interests

Not applicable

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Not applicable

Authors' contributions

XXX

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Authors' information

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Figures

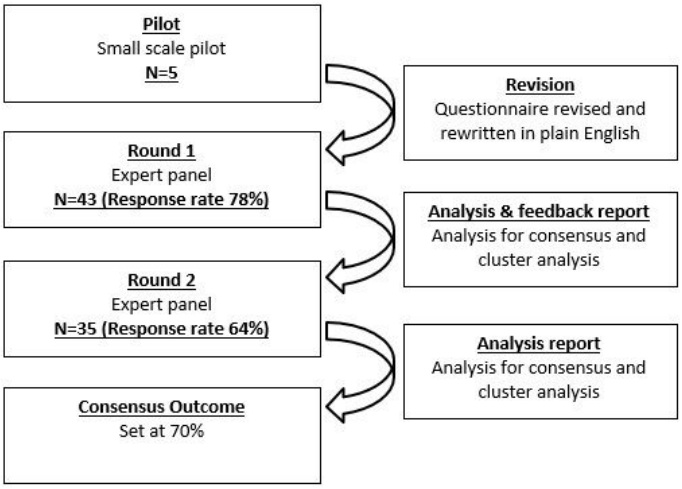

Figure 1

Study Process.

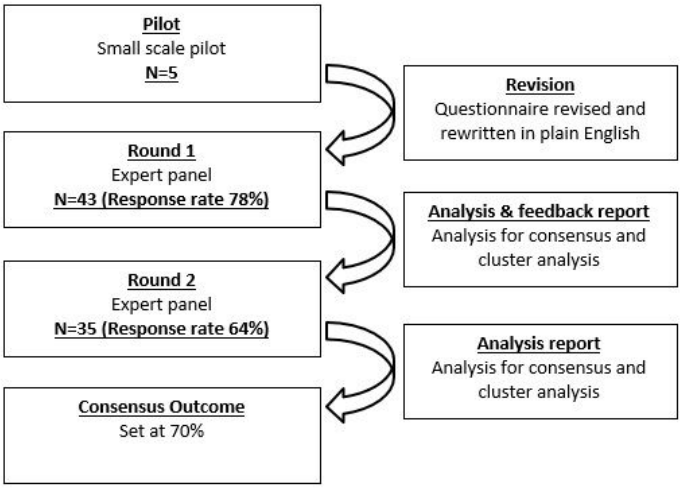

Figure 1

Study Process.